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EXAMINER

WILSON, CHRISTIAN D

ART UNIT

PAPER NUMBER

2891

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Please find below and/or attached an Office communication concerning this application or proceeding.

EL

Office Action Summary	Application No. 10/789,736	Applicant(s) YIN ET AL.	
	Examiner Christian Wilson	Art Unit 2891	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 19 October 2005.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-61 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-61 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 27 February 2004 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
 Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
 Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date <u>02272004, 05072004, 06072004, 10192005</u> | 6) <input checked="" type="checkbox"/> Other: <u>search history</u> . |

DETAILED ACTION***Specification***

1. The disclosure is objected to because of the following informalities: the phrase “absorption coefficient” is used when describing the property “k”. This property is properly described as the “extinction coefficient”.

Appropriate correction is required.

Claim Objections

2. Claims 1 – 61 are objected to because of the following informalities: the phrase “absorption coefficient” is used when describing the property “k”. This property is properly described as the “extinction coefficient”. Appropriate correction is required.

In the CRC Handbook of Chemistry and Physics, the extinction coefficient is defined as the absorption the electromagnetic wave energy in the process of propagation of a wave through a material. The wave intensity, I , after it passes through a material a distance x is equal to:

$$I = I_0 \exp (-\alpha x)$$

where α is the absorption coefficient. The extinction coefficient, k , is equal to:

$$k = \alpha (\lambda / 4\pi)$$

where λ is the wavelength of the light. Further, the Tauc relationship is defined as $(\alpha E)^{1/2}$ where E is the energy of the light.

In the instant application, the extinction coefficient is claimed in the range of:

$$0.001 < k < 0.15$$

which can also be described as:

$$2 \times 10^2 < \alpha [\text{cm}^{-1}] < 3 \times 10^4$$

$$19.8 < (\alpha E)^{1/2} [(\text{eV cm}^{-1})^{1/2}] < 242$$

where $\lambda = 633 \text{ nm}$ ($E = 1.96 \text{ eV}$).

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

4. Claims 1, 2, 7, and 10 are rejected under 35 U.S.C. 102(b) as being anticipated by He *et al.*

He *et al.* (Characterization and optical properties of diamondlike carbon prepared by electron cyclotron resonance plasma) discloses a method of forming an amorphous carbon layer [pg. 1055] for a semiconductor structure by introducing a carbon containing process gas [Table 1] over a wafer to form a layer having an extinction coefficient between 0.001 and 0.15 at a wavelength of 633 nm [Figure 5].

Regarding claim 2, He *et al.* further discloses subjecting the process gas and a spreading gas to RF energy to spread the plasma over the wafer [pg. 1056].

Regarding claim 7, He *et al.* further discloses a process gas of methane (CH_4) [pg. 1055].

Regarding claim 10, He *et al.* further discloses a process gas containing carbon and without oxygen [pg. 1056].

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

Art Unit: 2891

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claims 3 – 6, 8, 9, 11, 12, 14 – 25, 27 – 34, 37 – 40, 51 – 58, and 61 are rejected under 35 U.S.C. 103(a) as being unpatentable over He *et al.* in view of Fairbairn *et al.*

Regarding claims 3 – 6, He *et al.* teaches a spreading gas of argon (Ar) but does not discuss other gas mixtures. Fairbairn *et al.* (US 6,841,341) teaches using nitrogen (N₂), ammonia (NH₃), Ar mixed with N₂, or helium (He) as a spreading gas [column 6, lines 1-10]. It would have been obvious to one of ordinary skill in the art to use the spreading gases of Fairbairn *et al.* in the method of He *et al.* since Fairbairn *et al.* teaches that these are equivalent material choices to Ar when forming an amorphous carbon layer.

Regarding claims 8 and 12, He *et al.* teaches using CH₄ at a flow rate of 9 sccm [Table 1], but does not discuss using propyne (C₃H₄) or butane (C₄H₁₀) or propylene (C₃H₆) at a flow rate of 500 – 4000 sccm. Fairbairn *et al.* teaches the use of propyne, butane, and propylene at a flow rate of 500 sccm [column 6, lines 2 and 18]. It would have been obvious to one of ordinary skill in the art to use these materials since Fairbairn *et al.* teaches that these are equivalent material choices to methane for growing amorphous carbon layers and the increased flow rate provides an adjustable growth rate of the resulting layer.

Regarding claim 9, He *et al.* teaches growing the carbon layer at a temperature less than 100 °C. Fairbairn *et al.* teaches a growth temperature of between 150 and 480 °C [column 6, lines 50-55]. It would have been obvious to one of ordinary skill in the art to use the growth temperatures of Fairbairn *et al.* in the method of He *et al.* since these temperatures provide an adjustable control over the final extinction coefficient value.

Regarding claim 11, He *et al.* teaches using the carbon layer in an electronic device [pg. 1055], but does not teach using it as an insulating layer or antireflection coating (ARC). Fairbairn *et al.* teaches the use of transparent amorphous carbon layers as insulating films or ARCs in electronic devices [column 2, lines 10-15]. It would have been obvious to one of ordinary skill in the art to use the carbon layer of He *et al.* in the devices of Fairbairn *et al.* since these layers provide improved insulating and optical properties [pg. 1055].

Regarding claim 14, He *et al.* teaches a method of forming an amorphous carbon layer [pg. 1055] for a semiconductor structure by introducing a carbon containing process gas [Table 1] over a wafer to form a layer having an extinction coefficient between 0.001 and 0.15 at a wavelength of 633 nm [Figure 5]. He *et al.* does not describe a masking structure. Fairbairn *et al.* teaches forming a masking structure [Figure 2D]. It would have been obvious to one of ordinary skill in the art to form the carbon layer of He *et al.* with the masking structure of Fairbairn *et al.* since the carbon layer would act as an improved ARC with improved pattern replication [column 2, lines 10-20].

Regarding claims 15 and 16, He *et al.* teaches a spreading gas of argon (Ar) at a flow rate of 85 sccm but does not discuss other gas mixtures at higher flow rates. Fairbairn *et al.* teaches N₂ and NH₃ [column 6, lines 1-10]. It would have been obvious to one of ordinary skill in the art to use the spreading gases of Fairbairn *et al.* in the method of He *et al.* since Fairbairn *et al.* teaches that these are equivalent material choices to Ar when forming an amorphous carbon layer where the flow rates would be determined by routine optimization during experimentation.

Regarding claim 17, He *et al.* further teaches a process gas of methane (CH₄) [pg. 1055].

Regarding claim 18, He *et al.* further discloses a process gas containing carbon and without oxygen [pg. 1056].

Art Unit: 2891

Regarding claim 19, He *et al.* teaches growing the carbon layer at a temperature less than 100 °C. Fairbairn *et al.* teaches a growth temperature of between 150 and 480 °C [column 6, lines 50-55]. It would have been obvious to one of ordinary skill in the art to use the growth temperatures of Fairbairn *et al.* in the method of He *et al.* since these temperatures provide an adjustable control over the final extinction coefficient value.

Regarding claims 20 – 24, He *et al.* teaches using the carbon film in electronic device processing but does not describe forming a patterned carbon layer with an *in situ* silicon oxynitride layer which is removed with an oxygen plasma process. Fairbairn *et al.* teaches forming a patterned carbon layer [Figure 2D] with a silicon oxynitride layer **206** formed *in situ* [Figure 2B] and removed by an oxygen plasma process [column 8, lines 35-40]. It would have been obvious to one of ordinary skill in the art to use the pattern making process of Fairbairn *et al.* with the carbon layer forming method of He *et al.* since He *et al.* teaches that their method provides an amorphous carbon layer with improved optical transparency and ease of preparation.

Regarding claim 25, He *et al.* teaches using CH₄ at a flow rate of 9 sccm [Table 1], but does not discuss using propylene (C₃H₆) at a flow rate of 500 – 4000 sccm. Fairbairn *et al.* teaches the use of propylene at a flow rate of 500 sccm [column 6, lines 2 and 18]. It would have been obvious to one of ordinary skill in the art to use these materials since Fairbairn *et al.* teaches that these are equivalent material choices to methane for growing amorphous carbon layers and the increased flow rate provides an adjustable growth rate of the resulting layer.

Regarding claim 27, He *et al.* teaches a method of forming an amorphous carbon layer [pg. 1055] for a semiconductor structure by introducing a carbon containing process gas [Table 1] over a wafer to form a layer having an extinction coefficient between 0.001 and 0.15 at a wavelength of 633 nm [Figure 5]. He *et al.* does not describe a substrate with circuits. Fairbairn *et al.* teaches forming an amorphous carbon layer on a substrate **200** with circuits. It would have

Art Unit: 2891

been obvious to one of ordinary skill in the art to form the carbon layer of He *et al.* with the substrate of Fairbairn *et al.* since the carbon layer would act as an improved ARC with improved pattern replication [column 2, lines 10-20].

Regarding claim 28, He *et al.* teaches growing the carbon layer at a temperature less than 100 °C. Fairbairn *et al.* teaches a growth temperature of between 150 and 480 °C [column 6, lines 50-55]. It would have been obvious to one of ordinary skill in the art to use the growth temperatures of Fairbairn *et al.* in the method of He *et al.* since these temperatures provide an adjustable control over the final extinction coefficient value.

Regarding claim 29, He *et al.* further teaches a process gas of methane (CH₄) [pg. 1055].

Regarding claim 30, He *et al.* further discloses a process gas containing carbon and without oxygen [pg. 1056].

Regarding claims 31, He *et al.* teaches a spreading gas of argon (Ar) but does not discuss other gas mixtures. Fairbairn *et al.* teaches N₂ mixed with Ar [column 6, lines 1-10]. It would have been obvious to one of ordinary skill in the art to use the spreading gases of Fairbairn *et al.* in the method of He *et al.* since Fairbairn *et al.* teaches that these are equivalent material choices to Ar when forming an amorphous carbon layer.

Regarding claims 32 – 34, He *et al.* teaches using the carbon film in electronic device processing but does not describe forming a patterned carbon layer with a silicon oxynitride layer which is removed with an oxygen plasma process. Fairbairn *et al.* teaches forming a patterned carbon layer [Figure 2D] with a silicon oxynitride layer 206 and removed by an oxygen plasma process [column 8, lines 35-40]. It would have been obvious to one of ordinary skill in the art to use the pattern making process of Fairbairn *et al.* with the carbon layer forming method of He *et al.* since He *et al.* teaches that their method provides an amorphous carbon layer with improved optical transparency and ease of preparation.

Regarding claims 37 – 39, He *et al.* teaches using the carbon film in electronic device processing but does not discuss forming an ARC layer as integrated circuit with a plurality of devices. Fairbairn *et al.* teaches an ARC layer [column 2, lines 50-60] in an integrated circuit with a plurality of devices [Figure 3E]. It would have been obvious to one of ordinary skill in the art to use the amorphous carbon layer of He *et al.* in the structures of Fairbairn *et al.* since the carbon layer of He *et al.* provides improved optical transparency and ease of preparation.

Regarding claim 40, He *et al.* teaches using CH₄ at a flow rate of 9 sccm [Table 1], but does not discuss using propylene (C₃H₆) at a flow rate of 500 – 4000 sccm. Fairbairn *et al.* teaches the use of propylene at a flow rate of 500 sccm [column 6, lines 2 and 18]. It would have been obvious to one of ordinary skill in the art to use these materials since Fairbairn *et al.* teaches that these are equivalent material choices to methane for growing amorphous carbon layers and the increased flow rate provides an adjustable growth rate of the resulting layer.

Regarding claims 51 and 61, He *et al.* teaches a method of forming an amorphous carbon layer [pg. 1055] for a semiconductor structure by introducing a carbon containing process gas [Table 1] over a wafer to form a layer having an extinction coefficient between 0.001 and 0.15 at a wavelength of 633 nm [Figure 5]. He *et al.* further describes the processing system [Figure 1] but does not teach coupling controller which is a processor to an electronic device. Fairbairn *et al.* teaches forming an amorphous carbon layer where a controller 110 is coupled to an electronic device [Figure 1] by providing a processor 112. It would have been obvious to one of ordinary skill in the art to form the carbon layer of He *et al.* with the controller of Fairbairn *et al.* since the controller would provide proper control and regulation of the gas supplies.

Regarding claim 52, He *et al.* teaches growing the carbon layer at a temperature less than 100 °C. Fairbairn *et al.* teaches a growth temperature of between 150 and 480 °C [column 6, lines 50-55]. It would have been obvious to one of ordinary skill in the art to use the growth

Art Unit: 2891

temperatures of Fairbairn *et al.* in the method of He *et al.* since these temperatures provide an adjustable control over the final extinction coefficient value.

Regarding claim 53, He *et al.* further teaches a process gas of methane (CH₄) [pg. 1055].

Regarding claim 54, He *et al.* further discloses a process gas containing carbon and without oxygen [pg. 1056].

Regarding claims 55, He *et al.* teaches a spreading gas of argon (Ar) but does not discuss other gas mixtures. Fairbairn *et al.* teaches N₂ mixed with Ar [column 6, lines 1-10]. It would have been obvious to one of ordinary skill in the art to use the spreading gases of Fairbairn *et al.* in the method of He *et al.* since Fairbairn *et al.* teaches that these are equivalent material choices to Ar when forming an amorphous carbon layer.

Regarding claims 56 – 58, He *et al.* teaches using the carbon film in electronic device processing but does not describe forming a patterned carbon layer with a silicon oxynitride layer which is removed with an oxygen plasma process. Fairbairn *et al.* teaches forming a patterned carbon layer [Figure 2D] with a silicon oxynitride layer 206 and removed by an oxygen plasma process [column 8, lines 35-40]. It would have been obvious to one of ordinary skill in the art to use the pattern making process of Fairbairn *et al.* with the carbon layer forming method of He *et al.* since He *et al.* teaches that their method provides an amorphous carbon layer with improved optical transparency and ease of preparation.

7. Claim 13 is rejected under 35 U.S.C. 103(a) as being unpatentable over He *et al.* in view of Sudijono *et al.*

He *et al.* teaches a spreading gas of Ar at a flow rate of 85 sccm [Table 1], but does not discuss using He at a flow rate of between 200 and 1500 sccm. Sudijono *et al.* (US 2004/0092098) teaches a method of forming an amorphous carbon layer with a He flow rate of 100 – 1000 sccm [0034]. It would have been obvious to one of ordinary skill in the art to use the

Art Unit: 2891

spreading gas and flow rate of Sudijono *et al.* in the method of He *et al.* since this provides improved amorphization of the film [0034].

8. Claims 26 and 41 are rejected under 35 U.S.C. 103(a) as being unpatentable over He *et al.* and Fairbairn *et al.* as applied to claim 14 and 17 above, and further in view of Sudijono *et al.*

He *et al.* teaches a spreading gas of Ar at a flow rate of 85 sccm [Table 1], but does not discuss using He at a flow rate of between 200 and 1500 sccm. Sudijono *et al.* teaches a method of forming an amorphous carbon layer with a He flow rate of 100 – 1000 sccm [0034]. It would have been obvious to one of ordinary skill in the art to use the spreading gas and flow rate of Sudijono *et al.* in the method of He *et al.* since this provides improved amorphization of the film [0034].

9. Claims 35, 36, 42 – 50, 59, and 60 are rejected under 35 U.S.C. 103(a) as being unpatentable over He *et al.* in view of Fairbairn *et al.* and Zhou *et al.*

Regarding claims 35, 36, 59, and 60, He *et al.* as modified by Fairbairn *et al.* teaches an amorphous carbon layer in an electronic device application, but do not discuss the film in the semiconductor structure of the device as an insulation. Zhou *et al.* (Deposition and properties of a-C:H films on polymethyl methacrylate by electron cyclotron resonance microwave plasma chemical vapor deposition method) teaches an amorphous carbon layer as a passivation coating in an integrated circuit [pg. 273]. It would have been obvious to one of ordinary skill in the art to use the film of He *et al.* in the device of Zhou *et al.* since the properties of high hardness, high electric resistance, and high optical transparency are essential properties for use in semiconductor devices.

Regarding claim 42, He *et al.* teaches a method of forming an amorphous carbon layer [pg. 1055] for a semiconductor structure by introducing a carbon containing process gas [Table 1] over a wafer to form a layer having an extinction coefficient between 0.001 and 0.15 at a

Art Unit: 2891

wavelength of 633 nm [Figure 5]. He *et al.* does not describe processing a semiconductor structure for a memory where the temperature range is 150 – 500 °C. Fairbairn *et al.* teaches a growth temperature of between 150 and 480 °C [column 6, lines 50-55]. Zhou *et al.* teaches forming the amorphous carbon layer for a integrated circuit memory structure [pg. 273]. It would have been obvious to one of ordinary skill in the art to use the growth temperatures of Fairbairn *et al.* in the method of He *et al.* since these temperatures provide an adjustable control over the final extinction coefficient value and to use the film of He *et al.* in the device of Zhou *et al.* since the properties of high hardness, high electric resistance, and high optical transparency are essential properties for use in semiconductor devices.

Regarding claim 43, He *et al.* further teaches a process gas of methane (CH₄) [pg. 1055].

Regarding claim 44, He *et al.* further discloses a process gas containing carbon and without oxygen [pg. 1056].

Regarding claims 45, He *et al.* teaches a spreading gas of argon (Ar) but does not discuss other gas mixtures. Fairbairn *et al.* teaches N₂ mixed with Ar [column 6, lines 1-10]. It would have been obvious to one of ordinary skill in the art to use the spreading gases of Fairbairn *et al.* in the method of He *et al.* since Fairbairn *et al.* teaches that these are equivalent material choices to Ar when forming an amorphous carbon layer.

Regarding claims 46 – 48, He *et al.* teaches using the carbon film in electronic device processing but does not describe forming a patterned carbon layer with a silicon oxynitride layer which is removed with an oxygen plasma process. Fairbairn *et al.* teaches forming a patterned carbon layer [Figure 2D] with a silicon oxynitride layer 206 and removed by an oxygen plasma process [column 8, lines 35-40]. It would have been obvious to one of ordinary skill in the art to use the pattern making process of Fairbairn *et al.* with the carbon layer forming method of He *et*

Art Unit: 2891

al. since He *et al.* teaches that their method provides an amorphous carbon layer with improved optical transparency and ease of preparation.

Regarding claims 49 and 50, He *et al.* as modified by Fairbairn *et al.* teaches an amorphous carbon layer in an electronic device application, but do not discuss the film in the semiconductor structure of the device as an insulation. Zhou *et al.* teaches an amorphous carbon layer as a passivation coating in an integrated circuit [pg. 273]. It would have been obvious to one of ordinary skill in the art to use the film of He *et al.* in the device of Zhou *et al.* since the properties of high hardness, high electric resistance, and high optical transparency are essential properties for use in semiconductor devices.

Conclusion

10. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. The cited prior art teaches method of forming transparent amorphous carbon films.

11. A copy of the search history (EAST and STN) is enclosed.

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Christian Wilson whose telephone number is (571) 272-1886.

The examiner can normally be reached on weekdays, 7:30 AM to 4 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Bill Baumeister can be reached on (571) 272-1722. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Art Unit: 2891

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

A handwritten signature in black ink, appearing to read 'CW', with a large, stylized loop at the end.

Christian Wilson, Ph.D.
Primary Examiner
Art Unit 2891

CDW